

ADF



Saskatchewan
Agriculture
Development Fund



**COMPLIMENTS OF
AGRICULTURE DEVELOPMENT FUND**

*Keeping the agriculture and food industries competitive through Research,
Development and Demonstration.*

Final Report

R-89-12-0518

Parasitic Mites in Honey Bees: A Test of
Chemical Methods & Dev. of Survey Techniques

Funded by
The Agriculture Development Fund
March, 1991

Prepared by: John Gruszka

**PARASITIC MITES IN HONEY BEES: A TEST OF CHEMICAL
CONTROL METHODS AND DEVELOPMENT OF SURVEY TECHNIQUES**

FINAL REPORT

ADF PROJECT R-89-12-0518

SUBMITTED BY: SASKATCHEWAN BEEKEEPERS ASSOCIATION

PREPARED BY: JOHN GRUSZKA

EXECUTIVE SUMMARY

ABSTRACT

There were two objectives in this research project. The first was to conduct a survey of the beekeeping industry in Saskatchewan to determine the extent of the honey bee tracheal mite infestation. Secondly, to experiment with the use of menthol to determine the efficacy of this product as an agent to control mites and to determine residue levels.

As a result of the survey, the honey bee tracheal mite was found to be widespread in Saskatchewan. The mite was found in 40 individual beekeeping operations. It appears that the infestations all originated with bees which were imported from the U.S.A. during the summer of 1987. Generally speaking, the infestation rates are still low and not causing colony mortality or reduced honey production.

The use of menthol crystals appears to control tracheal mite infestations. It was determined that residues are not a problem in honey and the use of menthol as a miticide will be formally registered with Agriculture Canada Pesticides Directorate in the spring of 1991.

SUMMARY

An attempt was made to collect samples from every apiary of every commercial beekeeper in the province during the summer of 1990. Most of the samples were collected and submitted by the beekeeper. Approximately 1/4 of the samples were collected by project staff.

Samples were collected from 108 commercial operations and 32 hobby beekeepers from 1835 individual apiaries. Of these, 215 apiaries were found to have tracheal mite infestations. There are approximately 6,500 individual colonies in the infected apiaries.

Unfortunately, not all of the commercial beekeepers in Saskatchewan submitted samples during the 1990 survey. 23 individual operations were not examined. However, these beekeeping operations have been examined in previous surveys during 1989 and have all been found not to have tracheal mite infestations.

The honey bee tracheal mite is a serious economic pest and if left uncontrolled will cause colony mortality. To date, the infestation rates in most of the infested operations have been found to be very low. There are approximately six operations that have more than 50% of their apiaries infected. There are another six operations that have between one-half and one-quarter of their apiaries infected. The remaining infected operations have between one and four infected apiaries. Some operations have had identifiable tracheal mite infestations for two or three years and have been keeping the infestations at a low rate by the judicious application of menthol. To date, there have been no reports of colony mortality due to mite infestations however the infestation levels are rising in some operations to

the point where some winter mortality may be observed during the winter of 1990-91.

Menthol research has been conducted during 1989 and 1990. The results of the research indicate that menthol does work to control tracheal mite infestations. However, the window of opportunity for the application of menthol is narrow. Menthol crystals need to be applied when temperatures are sufficiently high enough to cause vaporization. This only happens later in the spring and early summer. Secondly, menthol cannot be applied during periods of honey flow to prevent residues in honey.

As a result of the information gathered, application has been made to Pesticides Directorate, Agriculture Canada to have the use of menthol legitimized for honey bee tracheal mite control. The efficacy and residue data collected during the course of this research has been instrumental in causing this to happen. Menthol should be registered for this use for the spring of 1991. Until this time, menthol use has been conducted under experimental use permit from Agriculture Canada.

TECHNICAL REPORT

A. THE SURVEY

ABSTRACT

A provincial wide survey of the commercial beekeeping industry was performed to determine the extent of the tracheal mite infestation in the province. This survey was to be co-ordinated with research work on a rapid detection method. It was intended to corroborate the traditional sampling method with a newly developed ELISA (Enzyme Linked Immuno-sorbent Assay) detection method to determine the most suitable method of surveying for tracheal mites in Saskatchewan.

BACKGROUND AND OBJECTIVES

It has been demonstrated that the honey bee tracheal mite has the potential to be a serious economic pest for beekeeping in Saskatchewan. The mite is not visible to the naked eye and has the ability to increase in population extremely rapidly. Consequently, a beekeeper could have a tracheal mite infestation and not be aware of the situation until the mite population had increased to the point where colony mortality was being experienced.

The project hoped to conduct a provincial wide survey using traditional survey methods and to compare the results to a new ELISA rapid detection method. It was hoped that the two survey methods could be compared and evaluated to determine if ELISA would be a suitable survey tool.

EXPERIMENTAL METHODS

Apiary samples of adult bees were collected and submitted for laboratory analysis. Each apiary sample contained 150 - 200 bees with 5 - 10 adult bees collected from each hive in the apiary. The bees were preserved in 70% alcohol.

Laboratory analysis involved making a thin thoracic disc which contained the tracheae. The thoracic discs were incubated in 5% KOH solution for 24 hours at 32°C to clear the muscle tissue. Once cleared the tracheae were stained with methylene blue and the analysis was performed using a dissecting microscope. Samples were submitted and collected from commercial beekeepers from across Saskatchewan.

Initial work on an ELISA detection method for tracheal mites has been performed by Dr. David Ragsdale at the University of Minnesota. When the initial project proposal was submitted Dr. Ragsdale indicated that he would be prepared to co-operate on the project. Unfortunately, due to problems with the antibodies in the lab in Minnesota, Dr. Ragsdale was not able to provide us with the necessary serum nor able to provide any analysis for us. As a

consequence, we were not able to compare the ELISA detection method with the standard survey techniques and laboratory analysis.

Recently, Dr. Don Nelson at the Beaverlodge Research Station has commenced research into perfecting an ELISA detection method for honey bee tracheal mites. The Saskatchewan Beekeepers Association, with funding from ADF, has contributed \$15,000 towards this research. It is hoped that this research will have a suitable antibody in a year's time and that this can be developed into a detection tool which can be used in the field by beekeepers.

RESULTS

Samples were received from 108 commercial beekeepers and 32 hobbyists. A total of 1836 apiary samples were collected and analyzed. Assuming apiary size of 30 - 40 colonies per apiary then this represents approximately 55,000 to 73,000 colonies.

As a result of the survey, a total of 41 beekeeping operations were found to have tracheal mites. The distribution of these finds is indicated in the map of Saskatchewan (Figure 1). There is a concentration of tracheal mite infestations in the north east and a scattering of individual infected operations across the province. The 41 infested operations is an increase from 22 which were found to be infested during 1989. Many of these operations have been sampled regularly for the past three years and were only found to have infestations during the summer of 1990. The common denominator seems to be package bees which were imported from the United States in 1986 and 1987. With few exceptions, the newly found infestations were identified in yards in which the last imported package bees were installed. It is not unusual that it would have taken three years for the infestations to build up to levels where they are detectable with the sampling method used in this study. First, low level infestations can stay at low levels for a number of years before they start to increase rapidly. Secondly, the sampling technique, by taking only 5 - 10 bees from every colony and analyzing only 100 bees from the apiary sample, is a low level of sampling. This rate of sampling necessitates high levels of mites in several colonies in the apiary before a positive is detected.

Of the 41 beekeeping operations that are known to have tracheal mites in Saskatchewan, 40 of these are commercial beekeeping operations and one is a hobbyist. There were a total of 215 apiaries identified as having tracheal mites. Again, assuming 30 - 40 colonies per apiary, this represents approximately 6500 to 8500 potentially infected colonies.

There were 23 commercial beekeepers who did not submit samples during the 1990 survey. However, these beekeepers would have been sampled during previous year's inspections. There is a possibility that the number of infected operations is higher since some of these 23 operations, which were previously not found to have tracheal mites, could now display tracheal mite infestations.

With very few exceptions, the levels of infestation have been very low (generally below 10%). Twelve of the operations surveyed have more than 50%

of their apiaries infested. The remainder (29 operations) have only one, two or three infested apiaries at this time.

Of those operations which have more than 50% of their apiaries infected, there are one or two operations which have infestation rates high enough that they could possibly sustain some winter loss during the winter of 1990-91. The rest of the infestations are at low levels and should not create any problems with wintering.

CONCLUSION

The results of the survey indicate that approximately one-third of the commercial beekeeping industry in the province has some level of tracheal mite infestation. Because of the distribution of the mite across the province and the simultaneous discovery in all of these diverse locations, it is predicted that the common source of infection was package bees which were imported in 1986 and 1987 from the United States.

The low levels of infestation detected indicate that the current sampling technique is unable to detect low levels of infestations until they have begun to manifest themselves and spread. Infestations were found in apiaries during the 1990 survey which in previous years had proven to be negative with the same level of sampling and analysis.

In spite of its inefficiencies, the survey methods were sufficiently good enough to provide early warning to beekeepers of the presence of infestations. The beekeeper now has the opportunity to apply menthol crystals to minimize the impact of this tracheal mite. If levels of infestation can be kept low, then the economic impact will be minimized or eliminated.

IMPACT ON SASKATCHEWAN AGRICULTURE

During the last four years there has been a significant decline in the number of colonies being kept in Saskatchewan due to poor economic returns. The advent of the tracheal mite will have severe economic consequences and impact honey production if left uncontrolled.

Because this pest is not visible to the naked eye, beekeepers have no opportunity to detect its presence at low levels of infestation. If left undetected and uncontrolled, mite levels will increase rapidly and colonies will die over winter. The result will be severe economic losses before the problem is even recognized. This has been the pattern of events in the United States.

As a result of this survey, beekeepers know whether or not their apiaries are infected at an early stage of infestation. This early detection provides the beekeeper with the opportunity to control the mite pest with the judicious application of menthol and to minimize the economic impacts.

Unfortunately, the rapid detection method (ELISA detection method) was not available for testing and comparison this summer. This project has now been

funded and it is hoped that it will put a reliable tool into the hands of beekeepers so that they can make their own field evaluation in the near future. Once this is accomplished, a beekeeper will have a rapid detection method and will be able to better cope with tracheal mite infestations. Until that time, an annual survey will need to be provided to ensure that beekeepers are aware of the status of the tracheal mite in their operation and able to initiate control methods to prevent economic impact.

TECHNICAL REPORT

B. MENTHOL TRIALS

ABSTRACT

Menthol crystals have been shown to control tracheal mite infestations in honey bee colonies. The menthol vaporizes and the menthol vapors enter the honey bee tracheae and kill the adult mites.

A variety of experiments were conducted to determine the efficacy of menthol treatments under Saskatchewan climatic conditions. The success of menthol depends on vaporization which is a function of temperature. As well, residue analyses were performed to ensure that the treatment did not create residue problems in honey.

BACKGROUND AND OBJECTIVES

Since the tracheal mite was first discovered in the United States, various researchers have reported control of honey bee tracheal mite infestations with the use of menthol in the United States. The success of this treatment depends on the external ambient temperature causing the menthol crystals to vaporize.

Most of this work has been conducted in the southern regions of the United States. Consequently, experiments were conducted under northern Saskatchewan conditions to determine the efficacy of such treatments. A variety of trials were conducted to determine the best time of application. Data were collected to determine the efficacy and residues.

Under Saskatchewan conditions the opportunity to treat colonies with menthol is limited to a very short time period in the early summer. Treatments need to cease during honey flow to reduce the potential residue problem. Often, temperatures are not suitable for fall treatment.

Ultimately, the experiments needed to determine whether or not menthol would work under Saskatchewan conditions. Secondly, if it did prove to be efficacious then the data collected would be instrumental in making a case for the registered use of menthol under the Pest Control Products Act so that this control would be available to beekeepers across Saskatchewan and Canada.

EXPERIMENTAL METHODS

The first menthol trials were conducted in La Ronge. This was done since, at that time, there were no tracheal mite infestations known in other parts of Saskatchewan. Preliminary trials indicated that further research should be conducted.

Once tracheal mite infestations were found in commercial beekeeping operations, experimental hives were donated by co-operant beekeepers who were found to have tracheal mite infestations.

Tracheal mite analysis was performed by collecting and analyzing 100 adult bees per colony. The bees were tested for the presence of tracheal mites by taking thin thoracic discs, clearing the muscle tissue in 5% KOH, staining with methylene blue, and examination under a dissecting microscope.

1. Efficacy

A variety of forms of menthol application were tested to determine the efficacy of menthol. Menthol in the form of synthetic pellets, menthol prepared in strips, and menthol prepared with vegetable shortening were compared to determine if there was a difference in efficacy. In all trials, the dosage applied was 50 g per hive.

Treatments were conducted on colonies which had varying amounts of initial infestations. As well, some colonies were treated over a two year period to determine the effectiveness of the menthol with continued application.

2. Winter Application of Menthol

During the summer of 1989 two beekeeping operations were found to be generally infested with tracheal mites. Each of these two operations co-operated in preparing one apiary each for wintering. The apiaries which were selected had produced an excellent honey crop (average 200 pounds plus per colony) and did not appear to be suffering unduly from tracheal mite infestations. The colonies were prepared for winter following normal recommended procedures for northern Saskatchewan. Samples for tracheal mite analysis were collected on September 18, 1989.

Hive treatments were applied on October 13, 1989. There were four treatment groups. The first group were control hives which received no treatment. The second group received a 12" X 12" piece of paper towelling soaked in canola oil. The paper towelling was placed between the two boxes of the brood chamber. The third treatment was to introduce 50 g of menthol pellets between the two boxes of the brood chamber. The fourth treatment consisted of four menthol strips (approximately 50 g of menthol in total) which was laid flat on the top bars of the lower brood chamber so as to be situated between the two brood chamber boxes.

The colonies were then immediately wrapped for winter and the treatments were left in place for the duration of the winter. The colonies were re-examined on April 2 and 3, 1990 at which point an adult bee sample was collected from each live colony for tracheal mite analysis.

3. Comparative Trials

A total of 164 experimental hives and 8 control hives were provided by four co-operating beekeepers. These hives were in apiaries that were known to have tracheal mite infestations.

Four different treatments were applied between June 13 and June 15, 1990 to the experimental hives. The four different treatments consisted of the following:

1. A 12" square sheet of paper towelling saturated in canola oil
2. A 500 gram extender patty (made of 150 g of vegetable shortening and 300 grams of granulated sugar)
3. 50 g of synthetic menthol pellets in a screened pouch
4. A 12" square piece of cardboard saturated with a 50-50 mixture of menthol and vegetable shortening (this application contained approximately 20 g of menthol)

The cardboard was placed on the bottom board of the hive and replaced after 7 - 10 days to ensure that the total amount of menthol applied to the colony approached 50 g. The menthol pellets were applied onto the bottom boards. The oil and patty treatments were placed on top of the brood chamber.

5. Analysis of Honey and Wax for Menthol Residues

1. Sample Preparation - Honey

A 5 g sample of honey was mixed with 3 g of anhydrous sodium sulfate and extracted with two 10 mL aliquots of acetone. The extracts were combined, dried over sodium sulfate and evaporated to 1.0 mL under a gentle stream of nitrogen.

2. Sample Preparation - Wax

A 2.5 g sample of wax was mixed with 2 g of anhydrous sodium sulfate and extracted with two 10 mL aliquots of acetone. The extracts were combined, chilled in an ice bath for 20 minutes, and then centrifuged. The supernatant was decanted, evaporated to about 4 mL, chilled and centrifuged. The supernatant was eluted through a conditioned C₁₈ Bond Elut cartridge followed by a 1 mL acetone rinse. The extract was reduced to 1.0 mL by evaporation under a gentle stream of nitrogen.

3. Analysis

The sample extracts and a series of menthol standard solutions (0.1 - 10 ug/mL) were analyzed by gas chromatography/mass spectrometry on a VG TRIO-2. Two uL aliquots were injected onto a 30 m DB-5 capillary column. With electron impact ionization, the fragment ions at 71, 81, 109 and 138 amu were monitored. Menthol concentrations in the extracts were determined from the standard curve. Concentrated extracts were diluted into the range of the standard curve. Recoveries from both honey and wax were >85% so no recovery corrections were made.

6. Control of Tracheal Mites With Management and Menthol

A group of 20 nucleus hives (two frames of bees and brood and a new queen cell) were established from a mite infested apiary. 50 g of menthol was applied to each nucleus hive shortly before and during the period of honey flow. Samples of adult bees were taken on June 28 before treatment began to determine the initial infestation and again on August 11 after treatment was complete to determine the infestation rate at the end of the summer.

RESULTS

1. Menthol Trials at La Ronge

The first menthol treatments were conducted at La Ronge on honey bee infested colonies. The results are shown in Table 1.

Four colonies were selected and treated. All treatments were conducted using natural menthol crystals. It should be noted that the results are somewhat variable. In one case the honey bee tracheal mite level was reduced to zero whereas in the other cases there was still some infestation present although the levels did decline.

Menthol treatment took place from mid-July until mid-August in two colonies and from the end of July until mid-October in the other two colonies. This latter group also had four times the dosage that the first group had.

Although the menthol appeared to have some impact it was discovered that the rate of menthol vaporization was very low and the menthol was applied during the period which, under normal conditions, a honey flow would be experienced. There was some doubt then as to how appropriate menthol treatment would be under Saskatchewan conditions.

2. Efficacy

During the summer of 1989 and 1990 tracheal mite infestations became common in the commercial beekeeping area. As a consequence, individual hives were offered for experimentation and menthol treatments were applied to determine the efficacy under commercial conditions. Table 2 indicates the results of two different menthol treatments on heavily infested honey bee colonies. The colonies used in this experiment had already experienced economic impact. While the rest of the operation from which these hives came produced a 200 pound honey crop the bees in this particular apiary were so heavily infested that they produced an average crop of approximately 70 pounds per hive.

When the menthol treatments were applied, the colonies were much smaller than normally expected for this time of year and the first round of honey had been removed from the hives. Ten colonies were chosen at random and each given either 50 g of synthetic menthol pellets or 50 g of synthetic menthol in strips. The pellets were placed on top of the second brood chamber and the strips were hung between brood frames in the second brood chamber.

It can be seen from Table 2 that the menthol treatments had a significant impact on the tracheal mite infestations. While the control colony infestations declined marginally during the experiment the treated colonies had a significant decline in their infestation rates.

Unfortunately, by the end of the experiment, these hives were not suitable for wintering. In spite of the fact that the menthol had reduced the infestation rates substantially, the bee populations had declined to such low levels that they were not sufficient to winter.

A second group of colonies, with low level tracheal mite infestations, were treated with menthol applications over a two year period. The results are tabulated in Table 3. Colony #1 exhibited a large increase in tracheal mite infestation during the winter of 1989-90. In the spring of 1990 the infestation rate had reached 59% and the colony was small in size. In spite of treatment with menthol the colony continued to dwindle and die by June 28, 1990. With this one exception, the remainder of the colonies seemed to be successfully treated with menthol treatments. The treatment in 1989 used menthol crystals which were placed on the top of the brood chamber. The menthol treatment in 1990 involved the use of menthol-shortening mix applied on cardboard to the bottom entrance. Both treatments seemed to keep the tracheal mite infestations at low levels.

3. Winter Application Trials

In the fall of 1989 two apiaries with average infestation rates of approximately 30% were chosen for treatment. Both of these apiaries had produced a better than average honey crop and the colonies appeared to be in excellent condition for wintering.

The experiment consisted of control colonies and colonies that were treated with one of three treatments: oil on paper towelling, menthol in pellet form and menthol in strips. The results of the experiment are shown in Table 4.

The first surprising observation was that many of the colonies were highly infested. Apparently, this infestation must have developed during the course of the summer and was apparently not a problem during honey production. Most of these highly infested colonies died during the winter.

Each of the treatments seemed to increase winter mortality. The control hives which did not have any treatment had an average of 35.3% winter mortality. The two menthol treatments had extremely high levels of winter mortality. Those colonies treated with oil on paper towelling had an intermediate level of winter mortality but still, at 50%, an unacceptably high level of winter loss. Clearly, none of the treatments had any impact on the mite levels. However, the application of menthol during the winter may have caused a significant increase in winter mortality. It is quite likely that the menthol aggravated the bees and disrupted the colonies during winter causing increased winter mortality.

Of the surviving colonies, only one had a decline in tracheal mite infestation levels. In all other colonies the infestation levels increased over the winter in spite of the application of the different treatments.

4. 1990 Comparative Trials

This experiment was designed to test the effectiveness of oil and shortening extender patties and compare this to menthol treatments for the control of honey bee tracheal mites. Field trials were conducted on colonies donated by four individual beekeepers. These colonies had a range of infestation rates, however, generally speaking, the infestation rates were low to moderate.

The results are shown in Tables 5 and 6 for the different treatments that were tested. Table 7 is a summary of the four different trials and the results from the four different beekeepers.

The average infestation rate of the control hives increased from approximately 5% to 14% over the course of the summer for a net increase of 162%.

The oil and shortening patty treatments did not appear to reduce the levels of infestations. However, the rate of increase for these two treatments was much lower than that of the control hives. This indicates that these treatments may have had some effect. The results were variable with infestations increasing in some colonies and declining in others.

Both menthol treatments consistently lowered the infestation rates. By coincidence, the colonies that received the menthol treatments happened to have higher infestation rates than those colonies which had the oil and patty treatments applied. In spite of this, the reduction in infestation rates was still greatest with the menthol treatments.

5. Management of Nucleus Hives

During the summer of 1988 twenty small nucleus hives were treated with menthol crystals during the summer. Treatment was continued through the honey flow. Table 8 indicates the infestation levels found before and after the menthol treatment. At the end of the treatment period, the infestation rates in all colonies diminished to the point where they could not be found.

This seems to indicate that treatment of smaller hives and for a longer duration of time may increase the effectiveness of the menthol treatment.

6. Residue Analysis

During the summer of 1988 a brood frame and some extracted honey was collected from the nucleus hive study for menthol residue analysis. The nucleus hives were treated with menthol throughout the duration of the honey flow.

The extracted honey indicated menthol residues of 0.52 parts per million. Both the wax and the honey from the brood comb were analyzed for menthol residues. Menthol residues in the wax were 11.1 ppm and in the honey were 0.08 ppm. The low residue in the brood-comb honey may have been due to the fact that the comb was removed for analysis after the colony had been given 4 gallons of sugar syrup for fall feed.

During 1989, samples were collected for menthol residue analysis from colonies which were treated only during the spring and not during times of honey flow. Three samples of extracted honey were analyzed. In all three cases there were no detectable menthol residues (detection limit = 0.03 ppm).

Menthol residue analysis was also performed on 12 brood combs which were collected from 5 separate beekeeping operations. The honey from these brood combs showed an average menthol residue of 0.29 ppm (range non-detectable to 2.22 ppm). Menthol residues in the wax in the brood comb had an average of

3.05 ppm (range 0.8 to 5.5 ppm).

There were however, two brood combs which showed menthol residues in excess of 100 and 200 ppm. These two brood combs contained menthol which had previously liquified, run down the brood combs and solidified on the face of the comb. Because of the special circumstances, these two combs were not included in the calculation of average residue levels of the wax and the brood combs.

CONCLUSIONS

Menthol has been proven to control tracheal mite infestations when used in a variety of formulations. However, the menthol-shortening mix applied on cardboards to the bottom entrance seems to be the best method of application. This treatment method is as efficacious as any, the method itself is the easiest to apply and this method reduces or eliminates the risk of residues caused by melting of menthol and having it run down the face of the brood combs.

Preliminary indications are that the oil and extender patties treatments do have some effect although the impact on the honey bee tracheal mite is not as effective as menthol treatments.

The best control of honey bee tracheal mite infestations occurs when menthol is applied to low level infestations. In such cases the infestations are eliminated or kept to a minimum. If allowed to increase, tracheal mite infestations can increase dramatically. In such cases, menthol is still effective in reducing the infestations. However, the damage caused by the honey bee tracheal mites to the colony can be severe enough that the colony population is reduced and the colony will die during winter.

Menthol treatment to outdoor wintered colonies during winter is not recommended. Menthol treatment during winter increased winter mortality. This was possibly due to the long term exposure of the hive to the menthol and the subsequent aggravation caused to the winter cluster.

The use of small nucleus hives and other management techniques with menthol treatment may prove to be useful in eliminating tracheal mite infestations.

If used appropriately (ie. not during the honey flow) there is little or no risk of menthol residues in honey.

IMPACT ON SASKATCHEWAN AGRICULTURE

If honey bee tracheal mite infestations are not treated, the infestations will build rapidly. These infestations will spread from colony to colony within an apiary, from apiary to apiary within an operation, and from one operation to another in the same geographical location. If left uncontrolled this pest will cause severe economic impact.

The judicious application of menthol works best if treatment is applied to low level infestations. Therefore, there is need for early detection. This has been supplied to the industry by the surveys that have been conducted in the last two years.

There is a narrow window of opportunity, however, menthol does work well enough to sustain productivity and profitability.

Since the tracheal mite has been found in 40 separate commercial operations it will be important to continue to monitor for this pest and to ensure that treatments are applied and all efforts made to minimize the impact.

TECHNOLOGY TRANSFER

The results of the survey conducted in 1990 were published in the December issue of Beelines which is sent to every registered beekeeper in Saskatchewan. The information regarding the menthol trials will be published in an upcoming issue of Beelines.

The results of the survey and the menthol trials was presented at the annual meeting of the Saskatchewan Beekeepers Association held February 7, 8, and 9, 1991 in Saskatoon.

Presentations were also made at the annual meeting of the Manitoba Beekeepers Association in Brandon on November 19 and 20, 1990 and at the annual meeting of the British Columbia Honey Producers Association held in Vernon on November 22 - 24, 1990.

This information will be presented to Alberta Beekeepers at a short course to be held in Edmonton, March 8, 1991.

PERSONNEL

The following people were employed during the course of these studies:

Fieldworkers

H. Mohr
D. Mohr
F. Andres
L. Monseler

Lab Technicians

C. Demkiw-Bartel
R. Meschishnick
K. White
L. Doig
D. Junor
N. Melnychuk
S. Meckelborg

Menthol residue analysis was performed by Dr. John Patterson, Agriculture Canada, Saskatoon.

EQUIPMENT

There was no capital equipment valued at \$500 or more purchased with funding for the project.

EXPENSE STATEMENT

Opening Balance		9,441.18
-----------------	--	----------

Income:	ADF	66,000.00	
	Menthol Sales	<u>684.60</u>	
		66,684.60	<u>66,684.60</u>
			76,125.78

Expenses:

(1) Menthol Trials:	Wages	6,600.00	
	Menthol	349.00	
	Sugar	<u>1,023.60</u>	
		7,972.60	7,972.60

(2) 1990 Survey and Menthol Trials:	Wages	60,319.41	
	Mileage & Exp.	3,772.51	
	Lab Supplies	403.26	
	Alcohol	1,069.88	
	Razor Blades	410.43	
	Menthol	968.40	
	Delivery Charges	72.60	
	Bank Charges	82.77	
	Accounting Fees (1988)	<u>370.00</u>	
		67,469.26	<u>67,469.26</u>
			75,441.86

BALANCE	683.92
---------	--------

Figure 1: Distribution of Tracheal Mites in Saskatchewan Apiaries, 1990

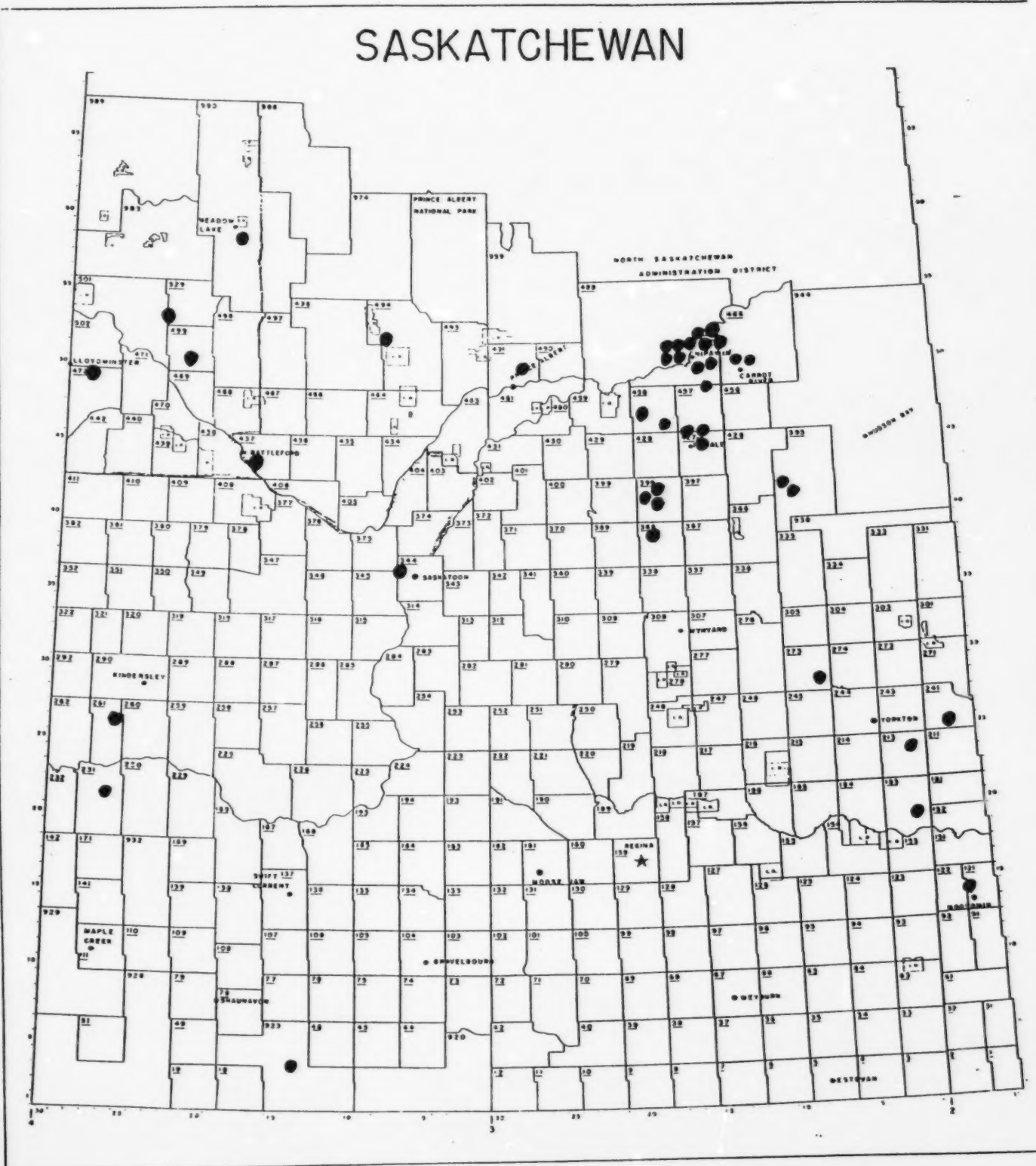


Table 1. Infestation Levels (%)* - La Ronge Menthol Treatments 1987

Col. #	May 1	June 3	July 8	July 30	Aug. 7	Aug. 13	Aug. 26	Sept. 23	Oct. 15
26 (1)	41	55	29		0	0		0	0
40 (2)	38	52	48		14	23		5	12
14 (3)	11	40	26	21	10	13	1	3	1
30 (4)	19	49	30	57	30	7	8	2	1

* 100 bees examined from each sample

- (1) 50 gram packet menthol crystals on bottom board July 13, exchanged after 14 days, removed day 32.
- (2) 50 gram packet menthol crystals on top bars July 13, exchanged after 14 days, removed day 32.
- (3) 2-50 gram packets menthol crystals on bottom board plus 2 packets on top bars July 30, exchanged after 15 days, left until October 15.
- (4) 2-50 gram dishes solid menthol on bottom board plus 2 dishes on top bars July 30, exchanged after 15 days, left until October 15.

Table 2: Results of Menthol Treatment of Heavily Infested Colonies

<u>Colony</u>	<u>Treatment</u>					
	<u>Control</u>		<u>Menthol Strips</u>		<u>Menthol Pellets</u>	
	<u>Before</u>	<u>After</u>	<u>Before</u>	<u>After</u>	<u>Before</u>	<u>After</u>
1	31	53	79	55	48	7
2	75	52	60	5	26	8
3	69	50	41	9	17	2
4	55	64	57	2	61	19
5	52	61	55	0	5	0
6	67	57	63	9	46	2
7	54	81	74	16	43	13
8	43	66	61	22	20	6
9	56	38	62	6	27	63
10	88	47	61	6	71	16
Average	59.0	56.9	61.3	13.0	36.4	13.6

Treatment applied July 26/89
after = August 29/89

Table 3: Control of Low Level Infestations with Early Summer Menthol Treatments

<u>Colony</u>	<u>May 31, 1989</u>	<u>August 31, 1989</u>	<u>April 12, 1990</u>	<u>June 28, 1990</u>
1	9	7	59	Dead
2	29	2	3	0
3	2	0	0	0
4	1	0	0	0
5	25	0	0	0
6	1	0	0	0
7	7	0	0	0
8	1	1	0	1
9	5	1	0	0
10	2	0	0	0
11	2	0	0	0
12	1	0	0	0
13	4	0	0	0
14	3	1	3	0

Table 4: Infestation Rates of Colonies Treated with Oil or Menthol During the Winter of 1989-90

<u>Control</u>		<u>Oil</u>		<u>Pellets</u>		<u>Strips</u>	
Sept. 18/89		April 2, 3/90					
<u>Before</u>	<u>After</u>	<u>Before</u>	<u>After</u>	<u>Before</u>	<u>After</u>	<u>Before</u>	<u>After</u>
12	25	52	D	16	3	13	D
45	75*	1	7	13	D	14	D
28	40	17	30	50	D	4	D
74	D	3	7	46	D	40	24
26	12	23	45	24	32	42	D
8	13	16	21	25	43	24	27
13	16	7	D	2	11	35	D
10	20	26	68	2	10	5	D
8	D	2	D	9	D	58	D
21	71	5	D	17	33	65	D
69	D	16	51	44	D	16	23
9	9	29	51	36	D	62	D
84	D	37	D	67	D	24	D
14	D	83	D	12	D	38	D
41	75	46	D	15	D	43	D
20	D	86	D	56	D	4	D
19	79			12	D	60	D
				68	D	4	D
Average Infestation of Surviving Colonies							
21.1	39.5	16.4	35.0	14.3	22.0	26.7	24.7
Average Infestation							
29.5	39.5	28.1	35.0	28.6	22.0	30.6	24.7
% Mortality							
	6 of 17		8 of 16		12 of 18		15 of 18
	35.3%		50%		66.7%		83.3%

Table 5: Impact of Oil and Extender-Patty Treatments on Tracheal Mite Infestations (1990)

TREATMENT		OIL			PATTIES		
BEEK.	COLONY	BEFORE	AFTER	%CHANGE	BEFORE	AFTER	%CHANGE
MARSHALL	1	8.00	5.00	-37.50	3.00	0.00	-100.00
	2	11.00	27.00	145.45	11.00	1.00	-90.91
	3	12.00	0.00	-100.00	0.00	0.00	0.00
	4	9.00	4.00	-55.56	3.00	0.00	-100.00
	5	8.00	12.00	50.00	0.00	0.00	0.00
	6	12.00	12.00	0.00	5.00	0.00	-100.00
	7	1.00	0.00	-100.00			
	8	9.00	0.00	-100.00			
	9	5.00	2.00	-60.00			
TOTAL		75.00	62.00	-17.33	22.00	1.00	-95.45
AVERAGE		8.33	6.89	-17.33	3.67	0.17	-95.45
ALEN	1	11.00	9.00	-18.18	7.00	11.00	57.14
	2	16.00	45.00	181.25	1.00	3.00	200.00
	3	10.00	23.00	130.00	0.00	4.00	100.00
	4	0.00	7.00	100.00	4.00	35.00	775.00
	5	0.00	10.00	100.00	0.00	2.00	100.00
	TOTAL	37.00	94.00	154.05	12.00	55.00	358.33
AVERAGE		7.40	18.80	154.05	2.40	11.00	358.33
ZOSEL	1	2.00	4.00	100.00	9.00	11.00	22.22
	2	2.00	1.00	-50.00	5.00	6.00	20.00
	3	3.00	4.00	33.33	12.00	12.00	0.00
	4	2.00	13.00	550.00	3.00	2.00	-33.33
	5	8.00	14.00	75.00	25.00	8.00	-68.00
	6	5.00	4.00	-20.00	62.00	72.00	16.13
	7	0.00	0.00	0.00	0.00	0.00	0.00
	8	0.00	2.00	100.00	8.00	6.00	-25.00
	9	3.00	1.00	-66.67	1.00	1.00	0.00
	10	1.00	1.00	0.00	0.00	18.00	100.00
	11	6.00	17.00	183.33	1.00	3.00	200.00
	12	3.00	27.00	800.00	0.00	0.00	0.00
	13	3.00	6.00	100.00	10.00	11.00	10.00
	14	1.00	4.00	300.00	13.00	5.00	-61.54
	15	8.00	23.00	187.50	40.00	31.00	-22.50
	16	0.00	1.00	100.00	14.00	85.00	507.14
TOTAL		47.00	122.00	159.57	203.00	271.00	33.50
AVERAGE		2.94	7.63	159.57	12.69	16.94	33.50
GAREZ	1	0.00	0.00	0.00	0.00	1.00	100.00
	2	0.00	4.00	100.00	8.00	31.00	287.50
	3	0.00	0.00	0.00	0.00	0.00	0.00
	4	0.00	1.00	100.00	0.00	0.00	0.00
	5	0.00	1.00	100.00	3.00	6.00	100.00
	6	8.00	3.00	-62.50	5.00	4.00	-20.00
	7	24.00	30.00	25.00	1.00	0.00	-100.00
	8	28.00	19.00	-32.14	0.00	0.00	0.00
	9	1.00	0.00	-100.00	10.00	16.00	60.00
	10	12.00	3.00	-75.00	2.00	6.00	200.00
	11				2.00	2.00	0.00
TOTAL		75.00	61.00	-18.67	31.00	66.00	112.90
AVERAGE		7.50	6.10	-18.67	2.82	6.00	112.90

Table 6: Impact of Menthol Treatments on Tracheal Mite Infestations (1990)

TREATMENT		PELLETS			CARDBOARD		
BEEK.	COLONY	BEFORE	AFTER	%CHANGE	BEFORE	AFTER	%CHANGE
MARSHALL	1	9.00	4.00	-55.56	6.00	0.00	-100.00
	2	26.00	2.00	-92.31	1.00	0.00	-100.00
	3	38.00	0.00	-100.00	11.00	0.00	-100.00
	4	7.00	0.00	-100.00	33.00	0.00	-100.00
	5	4.00	0.00	-100.00	7.00	0.00	-100.00
	6	7.00	3.00	-57.14	2.00	0.00	-100.00
	7	0.00	2.00	100.00	0.00	1.00	100.00
	8	2.00	1.00	-50.00	2.00	2.00	0.00
	9	1.00	1.00	0.00	11.00	0.00	-100.00
	TOTAL	96.00	16.00	-83.33	77.00	5.00	-93.51
	AVERAGE	9.60	1.60	-83.33	7.70	0.50	-93.51
ALEN	1	52.00	61.00	17.31	76.00	12.00	-84.21
	2	19.00	1.00	-94.74	56.00	1.00	-98.21
	3	7.00	2.00	-71.43	0.00	4.00	100.00
	4	24.00	2.00	-91.67	8.00	2.00	-75.00
	5	61.00	10.00	-83.61	0.00	4.00	100.00
	TOTAL	163.00	76.00	-53.37	140.00	23.00	-83.57
	AVERAGE	32.60	15.20	-53.37	28.00	4.60	-83.57
ZOSEL	1	12.00	3.00	-75.00	1.00	0.00	-100.00
	2	8.00	3.00	-62.50	39.00	10.00	-74.36
	3	1.00	1.00	0.00	96.00	11.00	-88.54
	4	0.00	1.00	100.00	5.00	1.00	-80.00
	5	19.00	2.00	-89.47	4.00	0.00	-100.00
	6	5.00	0.00	-100.00	36.00	4.00	-88.89
	7	4.00	2.00	-50.00	18.00	15.00	-16.67
	8	1.00	6.00	500.00	15.00	1.00	-93.33
	9	36.00	34.00	-5.56	0.00	0.00	0.00
	10	0.00	0.00	0.00	0.00	0.00	0.00
	11	2.00	0.00	-100.00	7.00	20.00	185.71
	12	0.00	0.00	0.00	0.00	21.00	100.00
	13	14.00	0.00	-100.00	0.00	0.00	0.00
	14	26.00	3.00	-88.46	0.00	2.00	100.00
	15	0.00	0.00	0.00	0.00	0.00	0.00
	16	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL	128.00	55.00	-57.03	221.00	85.00	-61.54
	AVERAGE	8.00	3.44	-57.03	13.81	5.31	-61.54
GAREZ	1	1.00	0.00	-100.00	10.00	0.00	-100.00
	2	2.00	0.00	-100.00	45.00	3.00	-93.33
	3	2.00	0.00	-100.00	31.00	0.00	-100.00
	4	0.00	0.00	0.00	0.00	0.00	0.00
	5	0.00	0.00	0.00	0.00	0.00	0.00
	6	0.00	1.00	100.00	1.00	0.00	-100.00
	7	2.00	0.00	-100.00	0.00	0.00	0.00
	8	0.00	0.00	0.00	0.00	0.00	0.00
	9	0.00	0.00	0.00	0.00	0.00	0.00
	10	7.00	3.00	-57.14	0.00	0.00	0.00
	11	0.00	2.00	100.00			
	TOTAL	14.00	6.00	-57.14	87.00	3.00	-96.55
	AVERAGE	1.27	0.55	-57.14	8.70	0.30	-96.55

1990 MITE CONTROL TRIALS

TREATMENT BECK.	COLONY	OIL			PATTIES			PELLETS			CARDBOARD		
		BEFORE	AFTER	%CHANGE	BEFORE	AFTER	%CHANGE	BEFORE	AFTER	%CHANGE	BEFORE	AFTER	%CHANGE
MARSHALL	9	75.00	62.00	-17.33		1.00	-95.45	96.00	16.00	-83.33	77.00	5.00	-93.51
ALEN	5	37.00	94.00	154.05		55.00	358.33	163.00	76.00	-53.37	140.00	23.00	-83.57
ZOSEL	16	47.00	122.00	159.57		271.00	33.50	128.00	55.00	-57.03	221.00	85.00	-61.54
GAREZ	11	75.00	61.00	-18.67		66.00	112.90	14.00	6.00	-57.14	87.00	3.00	-96.55
TOTAL	41	234.00	339.00	44.87	268.00	393.00	46.64	401.00	153.00	-61.85	525.00	116.00	-77.90
AVERAGE		5.85	8.48	44.87	7.05	10.34	46.64	9.78	3.73	-61.85	13.13	2.90	-77.90

CONTROLS

GAREZ	1	1	0	-100.00
	2	0	0	0.00
ALEN	1	9	43	377.78
	2	1	6	500.00
	3	31	64	106.45
MARSHALL	1	0	0	0.00
	2	0	0	0.00
	3	1	0	-100.00
TOTAL	8	43	113	162.79
AVERAGE		5.375	14.125	162.79

Table 8: Nuclei-Menthol Treatment

<u>Colony Number</u>	<u>Infestation June 28/88</u>	<u>Rate (%) Aug. 11/88</u>
1	4	0
2	1	0
3	0	0
4	2	0
5	0	0
6	11	0
7	0	0
8	1	0
9	2	0
10	0	0
11	0	0
12	2	0
13	0	0
14	0	0
15	0	0
16	0	0
17	0	0
18	4	0
19	0	0
20	0	0
	8 Pos.	0